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ABSTRACT

This case study of academic computing is one of a series focusing on computers as everyday learning and teaching tools which is addressed to administrators, teachers, staff, and students who wish to plan or improve the uses of computers at their own institutions. Following a brief description of the purpose and selection of cases for the overall study, the report profiles academic computing at Rutgers University, the state university of New Jersey, which has 46,000 students enrolled on seven campuses at New Brunswick, Piscataway, Newark, and Camden. The computing history of Rutgers is summarized, covering three decades of computer usage. The report describes the Center for Computer and Information Services (CCIS), which manages facilities and support for academic computing, and student access to computing facilities, including the CCIS, individual academic departments, and computing facilities provided by the New Jersey Educational Computer Network. Additional sections address costs and budgeting, the spectrum of computer applications at Rutgers, student accomplishments, computer literacy, computer science programs, outreach programs (sharing of software, expertise, and courses), plans and goals, and lessons learned. Contacts and 22 references are listed. (LMM)

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Academic Computing at Rutgers University

A Case Study

Beverly Hunter

1978

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Foreword

This book was prepared by the Human Resources Research Organization and supported by the National Science Foundation, Education Directorate, Grant Number SED-76-15399. Dr. Robert J. Seidel, Director of HumRRO's Eastern Division in Alexandria, Virginia, is Principal Investigator for the project, and Ms. Beverly Hunter is Co-Principal Investigator. Any opinions, findings, and conclusions or recommendations expressed in this book are those of the authors and do not necessarily reflect the views of the National Science Foundation.

The following individuals at Rutgers University contributed ideas, gathered information, and reviewed and edited manuscripts for this case study:

Dr. Saul Amarel, Professor and Chairman of the Computer Science Department

Richard F. Storer, Director of the Center for Computer and Information Services

Eugene P. Young, Associate Vice President for Computer and Information Services

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Jane Wallin, Center for Computer and Information Services

Kathleen Ciociola prepared the complete text of the chapter on the history of academic computing at Rutgers, entitled "The Past Three Decades."

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Academic Computing at Rutgers University

A Case Study

Purpose

This book is one in a series of twenty-one Case Studies of Academic Computing. The Case Studies focus on the ways in which computers have come to be an everyday tool and companion to students and teachers for the purpose of learning and teaching. The Case Studies are addressed to administrators, teachers, staff and students who wish to plan, extend, or improve the uses of computers at their own institutions. You should find the Case Studies helpful in performing one or more of the following kinds of activities.

1. *Assessing the extent and nature of instructional computing at your own institution, by comparison with the Case Institutions.*

We selected a range of different sizes and kinds of institutions so that you could find one that most closely resembles your own. The Case Institutions include secondary schools, public school districts, community colleges, colleges, and universities in most regions of the continental United States.

2. *Organizing and staffing your computer center to provide improved support for instructional computing activities.*

The Case Studies highlight those aspects of organization and staffing that appear to be most significant in encouraging beneficial uses of computers for learning and teaching.

3. *Making computer resources more accessible to students.*

The Case Studies identify policies, procedures, documentation, hardware, software, and courses that facilitate student use of computing.

4. *Establishing realistic educational goals for instructional computing.*

The sections on Student Accomplishments provide ideas as to the kinds of achievements students attained with the aid of computers.

5. *Extending computer applications in particular courses and disciplines.*

Information is available in Case Books and from the contact persons listed at the back of the book concerning the kinds of computer applications used in the various academic disciplines and courses.

6. *Raising the general level of computer literacy on campus.*

The section on Computer Literacy describes goals and programs aimed at educating students and faculty regarding computer uses and the impact of computers on society.

7. *Establishing or improving a computer science curriculum.*

Most of the Case Institutions have a formal program designed to train students in computer science and/or data processing.

8. *Sharing your facilities, expertise, or curricular materials with your community or other institutions.*

The section on Outreach describes the ways the Case Institution makes an impact on the world around it with regard to instructional computing.

9. *Preparing a Five Year Plan for academic computing at your institution.*

The organization of the Case Books might be a useful framework for presenting your own Five Year Plan. Also, most of the Case Institutions have their own Plans from which you may draw ideas.

Selection of Cases

Case Institutions were selected through a four-stage procedure. First, we conducted a systematic search for institutions that are regarded as outstanding in their uses of computers for learning and teaching. Invitations were mailed to seven thousand educators and technologists who belong to professional organizations concerned with educational computing. These individuals were invited to nominate one or more educational institutions that they regard as outstanding. Nominators were asked to give specific reasons why the school should be considered, given the objectives of our study.

Over 500 individuals responded, nominating 370 institutions that met our criteria.[1] Eligible institutions included individual elementary and secondary schools, public school districts, community colleges, colleges, and universities, and public access institutions such as museums.

Second, we contacted, at each nominated institution, an individual who has a purview of instructional computing activities. In many cases, this individual is the Director of the Computing Center or a Coordinator of Instructional Computing. The nominated institutions were happy to participate, and provided information about their activities via a telephone interview with a member of our staff. The product of this stage is an Academic Computing Directory, published by HumRRO, that gives brief information on the reasons for nomination, enrollment, typical computer applications, make and model of main computer(s), number of terminals on campus, and persons to contact.

Third, the nominees were invited to respond to one or more of a series of open-ended questionnaires corresponding to the following Categories of Excellence:

1. Institutional Commitment to Instructional Computing
2. Student Accomplishments
3. Institution Productivity
4. Spectrum of Applications
5. Computer Literacy
6. Computer Science and/or Data Processing Programs
7. Outreach
8. Model

[1] Projects, consortia, timesharing companies were not eligible.

These questionnaires were quite lengthy and required considerable work on the part of the respondents. By completing one or more of the questionnaires, the respondents demonstrated their willingness and ability to share information. Over one hundred of the nominees responded in one or more categories of excellence. HumRRO staff then reviewed all candidate institutions within each Category of Excellence. We selected as Exemplars in each Category those institutions that had provided complete answers and had demonstrated a high commitment to instructional computing. Consulting experts were called upon to review candidates in specific Categories. The product of this third stage is a list of Exemplary Institutions distributed by HumRRO.

Fourth, the Case Institutions were selected from among the Exemplars. The following criterion dimensions were used in selection:

1. High institutional commitment to academic computing as demonstrated by the survival of instructional computing over several budget cycles; staff support for instructional computing; reform of curriculum to incorporate computer uses; increases in appropriate computing equipment; incentives to faculty for instructional innovation.

2. High degree of computer literacy among students, faculty and administration, as reflected in student accomplishments, spectrum of applications, and number of computer users on campus.

3. Appropriate response to the Model questionnaire, and usefulness of all questionnaire responses.

Profile

Rutgers, the State University of New Jersey, is a large university ranking nineteenth in enrollment among American universities. Chartered as Queen's College in 1766, the institution grew slowly until Rutgers was designated as the State University of New Jersey by an act of the Legislature in 1945. As a result of expansions and mergers with independent colleges in New Jersey, the University has evolved into a complex federation of schools offering a variety of learning environments. Today, the University has over 46,000 students on seven campuses in New Brunswick, Piscataway, Newark, and Camden. There are 24 instructional divisions and 16 affiliated research units.

The Board of Governors, established under the State Legislature's reorganization act of 1956, has general supervision over and is vested with the conduct of the university. The Board is composed of 11 voting members and two ex officio: The Chancellor of the State Department of Higher Education and the President of the University. There are also two nonvoting faculty members and one student representative.

The full-time instructional faculty of the university numbers approximately 774 full, 615 associate, and 773 assistant professors. Approximately 50% of these faculty members are tenured.

During the 1976-77 academic year, the State University conferred a total of 9,038 degrees. Included were 415 doctorates, 2,053 master's degrees, 6,130 baccalaureates, 20 associate degrees, 405 juris doctorates, and 15 specialist in education degrees.

Ninety-five percent of undergraduate students and 80% of graduate students are New Jersey residents. About 35% of all students attend the University on a part-time basis. In recent years, the proportion of women and minority students has been increasing. In 1977, women represented 48% of the student population. Eighteen percent of the total student body in 1977 were members of minority groups. Forty percent of the University's students are over 25 years of age.

The 1978-79 budget for the State University totaled $219,973,685, the major parts of which were provided by the State of New Jersey (50%), and by student tuition and fees (17%). Undergraduate tuition, exclusive of fees, is $760 per year for New Jersey residents and $1,520 for out-of-state residents.

The Past Three Decades

Academic computing at Rutgers has a long and complex history, beginning in the 1940's. From the beginning until 1963, leadership and management of computing were provided by the Mathematics Department. In 1963, university-wide academic computing was formally recognized through establishment of the Center for Information Processing.

Prior to 1968, academic computing developed relatively independently of other institutions within the State. Since 1969, Rutgers has been involved in a series of New Jersey state educational computing network organizations.

The following chronology highlights the major hardware, software, organizational, application and financial events that have led to the present state of academic computing at Rutgers.

MATHEMATICS DEPARTMENT LEADERSHIP – 1946-1963

1946 Dr. Fred G. Fender, pioneer in promotion of computers at Rutgers, was named professor of mathematics.

1948 Numerical Analysis taught under contract with the U.S. Army Signal Corps, and subsequently introduced by the Mathematics Department in the College of Arts and Sciences.

1950 Professional Computing Conference co-hosted by Rutgers College of Engineering and Association for Computing Machinery. Theme: "To help engineers and executives understand the numerous things that a computer of moderate cost can do."

1953 Mathematics Department brochure encourages student interest in computing: "The growing use of modern electronic computing machines (often referred to as Giant Brains) provides an exciting new field for mathematicians."

1954 First computer hardware installed: IBM 402. Used informally by Fender's mathematics students.

1957 Courses in Information Processing added to University College curriculum.

1958 First Stored Program Computer Installed: IBM 650. International Business Machines Inc. provided 60% educational discount.
Computation Center established, with Dr. Fender as Director. The Computation Center was an informal division within the Mathematics Department.

1958-60 Early research uses of the computer included research in dairy cattle genetics, soils and crops, biology, meteorology, and sociology.

1961 NSF sponsors Summer Conference on Computer Programming for College Teachers. Held again in 1962.

First Computer Related Degree Program, an interdisciplinary M.S. program in Systems Analysis, approved by the graduate faculty.

1962 Major hardware improvement, largest IBM 1620 in the world installed to replace the 650.

Computation Center staff expanded to include a new Assistant Director, an "Associate Professor of Information Processing," four faculty, secretary, and two programmers.

Ford Foundation Program for the Retraining in Mathematics of College Women includes two computer courses. Program continues into late 1960's with NSF support.

Administrative Advisory Committee formed by the Provost to act on policy and personnel matters related to Computation Center.

1963 Physics Department becomes major computer user, with research for Bell Laboratories Van De Graaff accelerator and bubble chamber research.

CENTER FOR INFORMATION PROCESSING (CIP) 1963-1966

1963 Information Processing becomes a recognized academic department of Rutgers University, with the creation of the Center for Information Processing (CIP). CIP is responsible for hardware, software, services, and education.

Formal customer billing system introduced, and a monitor installed on the computer to safeguard against unauthorized use. Center has 40 accounts with an average of two persons per account.

CIP provides non-credit training for 300 faculty and graduate students on subjects including Fortran programming and machine operations.

1964 College of Engineering requires computer literacy. Faculty votes to require all freshmen to take a one-credit course in "Basic Computer Programming."

Major hardware improvement: IBM 7040/1401 installed. Features: 32,768 words of storage, extended instruction set, single and double precision floating point arithmetic, internal clock, memory protect, direction connection to 1401.

Reorganization of CIP. Computer Division includes computer operators, computer programming, computer library, and systems programming. Education staff expanded to 12.

CIP Monthly News Bulletin introduced.

Conference on the Use of Computers in Humanistic Research sponsored by Rutgers and IBM, included papers on computers in historical, literary, and musicological research.

1965 Major hardware improvement, an IBM 1301 disk drive added to the 7040 for use by IBSYS monitor in compiling and executing programs.

Program library expanded. Programs from SHARE (IBM users cooperative) are received on magnetic tape. Nine statistical analysis programs from the Biomedical Computer Program Series of UCLA are also made available to Rutgers users.

Long range plan for academic computing includes four major recommendations to the Rutgers administration:

- Create an academic department within the College of Arts and Sciences to offer a major in Computer Science.
- Increase staff of the computer facility.
- Study the merits of timesharing, a recent technological improvement.
- Consider a merger of academic and administrative computing.

1966 Department of Computer Science established within the Livingston College, to offer instruction and research programs at the bachelor, masters, and eventually doctoral levels.

CENTER FOR COMPUTER AND INFORMATION SERVICES (CCIS) – 1966-Present

1966 Center for Computer and Information Services (CCIS) established to provide support services for academic (instructional

and research) computer users, and provide laboratory facilities to the Department of Computer Science. CCIS to be under the jurisdiction of the Assistant Provost for Academic Services.

Camden and Newark Branches of CCIS Established.

Punched cards were transmitted to computer in New Brunswick via express mail runs.

1967 Newark branch of CCIS installs IBM 1130.

Hardware owned by Academic Departments:

Physics owns PDP 6, SDS 910, and SDS 925; College of Engineering owns PDP 5 and RPC 4000.

Rutgers requests $2.3 million from National Science Foundation for a Computer Facility Grant for a three-year period (7/68-7/71). The funds would help to defray rental costs of an IBM 360/67 and to purchase an RCA Spectra 70/46.

1968 AID Station opens to offer "assistance in debugging." Help available to students and faculty from staff members, volunteers, and student ACM members.

Establishment of a Joint CCIS Engineering Facility.

IBM 1130 moved from CCIS to College of Engineering, University Heights Campus. CCIS will be responsible for the overall operation while the College of Engineering will provide supervision and a computer operator.

NSF grant of $600,000 received for computer facility.

1969 Beginning of Third Generation Computing.

Arrival of IBM 360/67 allows Rutgers to begin remote-job-entry and timesharing. IBM 7040 leaves. Operating schedule expanded to three full operating shifts.

Applications Group uses disk space.

The entire CCIS Library of Programs, including documentation, source code, and object modules, is converted to disk storage made possible by the IBM 360.

Collaboration between Rutgers and Princeton.

Rutgers provides faculty and student access to TSS, a time-sharing system, from 3 p.m. to 9 p.m. daily on its IBM 360/67 while Princeton provides batch services from its large "number cruncher," an IBM 360/91.

RJE begins from Camden to New Brunswick. IBM 1130 installed.

1970 IBM 360/67 operating under control of HASP-driven OS-MVT system with the following software: ASM F, ATS, ALGOL, COBOL, FORTRAN G and H, GPSS, LISP, PL/1 F, RPG, SNOBOL 4, and WATFOR.

1971 Special Research Resource on Computers in Biomedicine.

The National Institute of Health awards the Department of Computer Science a three-year grant of $575,722 to develop a computer system for diagnosis and treatment of glaucoma in cooperation with researchers from Mount Sinai Medical School, New York, Columbia-Presbyterian Hospital, New York, and the Veterans Administration Hospital in East Orange, New Jersey.

Unsuccessful attempt to combine academic and administrative computing.

Policy Committee on Computing recommends establishment of a director of "University Computing and Information Processing" to coordinate planning and budgetary arrangements for both CCIS and AIS (Administration Information Services).

1972 Hill Center Opens

CCIS staff and computer hardware move from Records Hall into "Hill Center for the Mathematical Sciences." The building provides facilities for instruction and research in Mathematics, Statistics, Computer Science, and the Computer Room. Monies for construction came from the State of New Jersey, the State's 1968 Higher Education Bond Issue, and grants from the United States Office of Education. The NSF furnished additional funds for furnishing the Mathematical Sciences Library and a colloquium area.

Sharing of Rutgers Computing Power.

Through its increasing involvement in the statewide computer network, Rutgers allows other colleges and universities in New Jersey to consume 20% of the available batch capacity and 60% of the available timesharing services. (Approximately 5% of Rutgers computer needs are met through a continuing arrangement with Princeton.)

Users Manual (Version 1) Published

A 550 page comprehensive document detailed central administration computing policy, systems and hardware specifics, job control language, timesharing facilities and commands, utilities and packages, major programming languages, specifics of the Newark and Camden operations, and a glossary of terms.

Academic Departments Acquire More Hardware.

With extensive support from the NSF, the Physics Department satisfies its computing needs by operating a sophisticated computer center independent of CCIS.

Bubble Chamber Group: PDP-10, PDP 6, and PDP-8 systems including card reader, line printer, paper tape reader and punch, 10 tape devices, one disk, Calcomp

Plotter, and a Tektronix Storage Display Scope. All computing is done interactively on 10 Teletype Model 35 timesharing consoles in a variety of languages. Special equipment features an on-line film measuring system and automatic pattern recognition and measurement device for line drawings.

Nuclear Physics Group — A Xerox SIGMA 5 with an on-line Calcomp plotter is used for data reduction and analysis with some batch processing in FORTRAN and METASYMBOL. A Xerox SIGMA2 is dedicated to the acquisition of data from the Nuclear Physics Laboratory's Tandem Van de Graaff Accelerator. A third Xerox system, XDS 910, is used primarily for back up to the SIGMA2.

Other Physics Users — The Solid State Research Group operates a DEC PDP 8E-AA system.

Other Departments have acquired a variety of hardware primarily dedicated to on-line monitoring of research experiments.

Electrical Engineering; PDP 5, PDP 8 with 4 teletypes, Analog EAI 580, and Analog EAI TR-10.

Chemical Engineering; Analog EAI TR-20, Analog EAI TR-48.

Mechanical and Aerospace Engineering; Analog EA TR-10, Honeywell 5600 Agricultural Engineering, Analog TR-20, COMP DYNA GP6 Analog.

Psychology; PDP 8L, PDP 8E, PDP 8L, PDP 8L

Graduate School of Library Service; IBM 2770 terminal, IBM 1130.

Institute of Animal Behavior; IBM 2770 terminal.

1973 Rutgers University Extension Division offers "Computer Clinic for Non-Computer Managers."

Rutgers selected to join ARPA (Advanced Research Projects Agency) network.

Research grant to Department of Computer Science provides equipment to connect with Illiac IV at NASA (Ames, California), MIT, Stanford University, and University of Southern California.

DEC PDP 10 arrives.

Primarily intended for advanced timesharing for artificial intelligence research in Department of Computer Science.

1974 SUMEX established. (Stanford University Medical Experimental Computer Center)

Rutgers, Stanford University, and the National Institute of Health collaborate to form computer research center. Dr. Saul Amarel (Chairman of Rutgers Computer Science Department), Dr. Joshua Lederberg (Nobel prize winning geneticist from Stanford) and an NIH representative form the executive committee.

Mapmaking by Computer Conference co-sponsored by CCIS and the Rutgers College Department of Geography.

Three-year grant for $1,124,329 received from the National Advisory Research Resources Council of NIH. Dr. Saul Amarel is principal investigator of grant to foster development of national network of collaborators from various universities and medical schools in Artificial Intelligence in Medicine (AIM).

IBM 370/158 arrives.

The 370/158 has 2 million bytes of fast memory, replacing 2 million bytes of AMPEX ECM (slow core) plus 512K bytes of fast core on the 360/67. A 3330 disk unit replaces one 2314 and 2319 used on the 360.

1975 AIM Workshop (Artificial Intelligence in Medicine) sponsored by Rutgers Research Resource on Computers in Biomedicine (yearly workshop repeated during summers of '76, '77, and '78).

Rutgers CCIS Hosts Third Annual ACM SIGUCC Conference.

Featured speakers from Rutgers, MIT, EDUCOM, CUNY, IBM, and Michigan State focus on "Directions for User Services." Conference attendees came from 140 institutions in Canada and United States.

1976 Third Annual Conference on Computers in Higher Education co-sponsored by NJECN and the Department of Computer Science.

Open house held at CCIS featuring computer art contest, vendor displays, demonstrations of electronic voice synthesizer and graphic systems for artists, talks by Rutgers Faculty on the use of computers in education, an IBM film "Creative Classroom Computing," and facility tours.

1977 Computer and the Arts Conference

Co-sponsored by CCIS and the Rutgers School of Creative and Performing Arts.

1978 PDP 11/60 replaces IBM 1130 at College of Engineering

Administrative Consolidation of Computing

Mr. Eugene P. Young, Associate Vice President for Academic Affairs, appointed first Associate Vice President for Computers and Information Services in charge of all academic, administrative and library computing. Prior to the reorganization, academic computing (CCIS), administrative computing (CCMS), and library computing (RULCC) reported

respectively, to independent areas - Academic Affairs, Budget and Program Planning, and the Library System.

Hardware Upgrade for Computer Science Research.

DECSYSTEM KL 2050T replaced PDP 10.

EVENTS RELATED TO NEW JERSEY COMPUTING NETWORKS AND RUTGERS[1]

1966 Board of Higher Education created by state legislation.

Rutgers establishes Computer Science Department and the Center for Computer and Information Services (academic computing) by an internal reorganization.

1967 Department of Higher Education created; Ralph Dungan appointed Chancellor.

Dec 1968 Board of Higher Education directs Chancellor to assist in computer development planning.

Feb 1969 Chancellor appoints a Computer Network Study Committee; meetings begin.

Mar 1969 Rutgers receives IBM 360/67 partially financed by $600,000 Computer Facility Grant from National Science Foundation. Remote-job-entry (RJE) and timesharing begin on third generation machine.

Aug 1969 Agreement drawn up between Rutgers and the DHE which establishes the interim New Jersey Educational Computer Center (ECC).

[1] For further information on the development of New Jersey networks, see Heydinger, (1976).

Jan 1970	Master Plan for Higher Education published by DHE.
Aug 1970	NSF Grant received for the development of ECC.
Sep 1970	ECC incorporates. "Memo of Agreement" between ECC, Rutgers, and Princeton formalizes the ECC.
Aug 1970-June 1972	ECC serves 23 colleges and universities in New Jersey utilizing the Princeton 360/91 and the Rutgers 360/67. ECC does not own hardware.
Sep 1971	Dr. Edward J. Bloustein replaces Dr. Mason Gross as President of Rutgers - The State University.
1971	National Institute of Health awards the Rutgers Computer Science Department a three-year grant of $575,722 to establish a Special Research Resource on Computers in Biomedicine.
1972	Rutgers University Library Computer Center begins; CAPTAIN project for Library Automation starts.
Mar 1972	Formation of "XYZ Computing Consortium" discussed by DHE and Rutgers.
May 1972	Rutgers University Senate ad hoc computer committee objects to XYZ plan. XYZ Consortium collapses.
June 1972	NSF Grant to ECC terminated. Rutgers Task Force reviews issue of centralization of computers.
Jul 1972	ECC terminated; Educational Information Services, Inc. (EIS) incorporated as transition network.

Jul 1972	Blue ribbon task force appointed by Chancellor to examine the assumptions of networking.
Nov 1972	Blue ribbon task force submits report to DHE recommending that EIS provide administrative and academic computing from its own staff and hardware.
Fall 1972	EIS decides to rent IBM 370/158 and have Princeton manage it.
Dec 1972	Academic Services Division of EIS is formed
Spring 1973	Blue ribbon task force report approved by Board of Higher Education.
1973	Rutgers Computer Science Department selected to join ARPA (Advanced Research Projects Agency) with NASA, MIT, Stanford University, and University of Southern California. Rutgers administrative computing upgrades hardware from IBM 360/30 to IBM 370/135.
Fall 1973-Summer 1975	EIS provides computing services from Princeton interfacing PU's/91 with EIS'/158.
Fall 1973	Rutgers makes decision to purchase PDP 10 for artificial intelligence research in Computer Science Department and IBM 370/158 for general academic computing; notifies DHE after letter of intent is sent to vendors.
1974	Rutgers' Computer Science Department receives three year grant from National Institute of Health for $1,124,329 for research in Artificial Intelligence in Medicine (AIM). Rutgers, Stanford, and NIH also collaborate to form SUMEX (Stanford University Medical Experimental Computer Center).

Apr 1974 Major Confrontation between Chancellor Dungan and President Bloustein over autonomy.

Department of Budget forbids Rutgers to use state monies to pay for IBM 370/158.

Sep 1974 Under leadership of Alice Irby, a Rutgers Vice-President, three college presidents form ad hoc planning committee to design a new computer utility.

Nov 1974 Ad hoc planning group produces a proposal entitled, "Outline for the Rutgers-State Colleges Proposal for a Computer Utility."

Jan 1975 EIS is officially renamed the New Jersey Educational Computer Network (NJECN).

Title for the Rutgers IBM 370/158 is transferred to ECN.

June 1975 Princeton facility management contract terminated. Rutgers 370/158 and 370/135 turned over to ECN.

Aug 1975 ECN purchases IBM 370/168; ECN/135 phased out.

Center for Computer and Information Services

Facilities and support for academic computing are managed by the Center for Computer and Information Services (CCIS). The Director of CCIS reports to the Associate Vice President for Computer and Information Services. This Associate Vice President supervises the Directors of the CCIS, the Center for Computer and Management Services (administrative computing), and the Library Computer Center. He reports directly to the Executive Vice President of the University.

A Computer Policy Committee is composed of Vice Presidents from areas such as Student Services and Planning, as well as members of the faculty and the Associate Vice President for Computer and Information Services. The Policy Committee reviews and endorses technical, budget, and strategic proposals from the Directors of the academic, administrative, and library computing centers.

FUNCTIONS OF CCIS

CCIS provides support services to students and faculty who use computing for instruction and research purposes. Services include education courses, Computer Reference Center, newsletter, consulting, maintenance of terminals and remote job entry facilities, equipment loaned for classroom use, program package support, data archives and data base management, systems programming, documentation, accounting, and billing.

CCIS purchases computer time for its users, primarily from the New Jersey Educational Computer Network (NJECN), a state computer utility.

CCIS ORGANIZATION

CCIS has its main offices at the Busch Campus in Piscataway. Camden and Newark campuses each has a CCIS manager, who reports to the CCIS Director. CCIS maintains a staff of 45 persons, organized as shown in Figure 1. CCIS also employs about 70 students per year on a part-time basis.

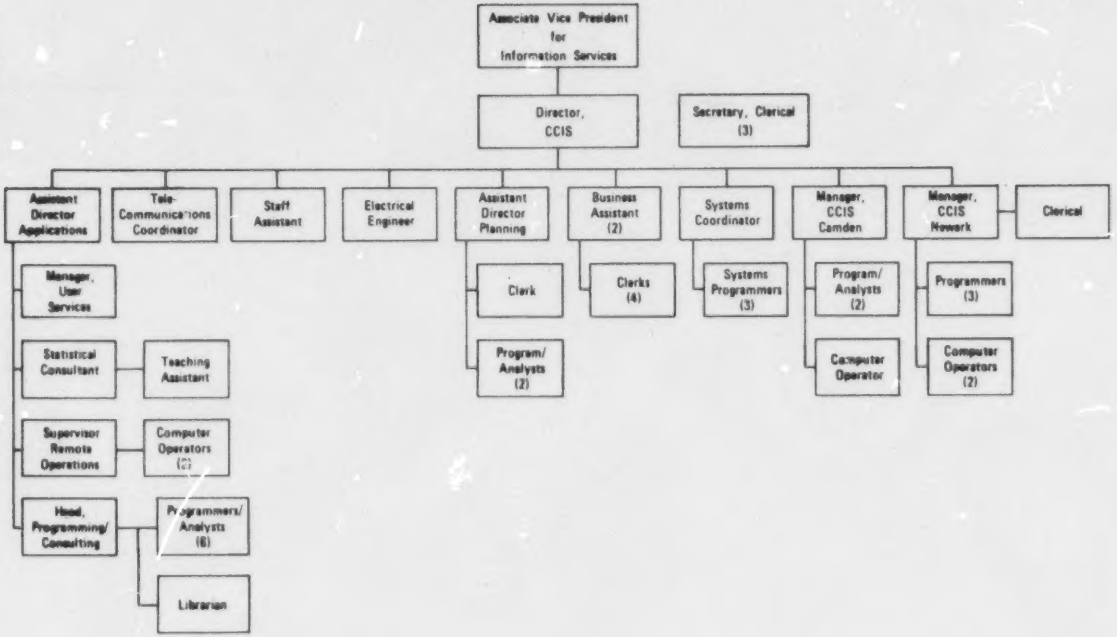

Figure 1. **Organization of CCIS**

CCIS ADVISORY COMMITTEES

An Advisory Committee composed of faculty members from all campuses reviews plans for CCIS. It is the principal sounding board for new proposals by interested faculty members, administrators, and CCIS management. The Chairperson of the Advisory Committee serves on the Policy Committee.

Users at Camden, New Brunswick, and Newark campuses are represented by local advisory committees. The Newark group is appointed by the Newark Provost.

RUTGERS DATA BASE ADVISORY COMMITTEE

Rutgers, like many educational institutions, has memberships in several national organizations from whom machine-readable data files are purchased; in addition, computer tapes are acquired from governmental agencies, nonprofit corporations, and other colleges and universities. Until 1977, the administration of these memberships was handled by faculty members of individual academic departments. This arrangement was unsatisfactory because faculty, students and researchers from other departments had no centralized place to call for information concerning availability of data files, titles, volume serial numbers, code books, and the like, and the member faculty did not have the time and staff to provide these services. Quite often, faculty and students from other departments were unaware of the existence of data files.

To remedy this situation, CCIS proposed to centralize data archiving services and create a Data Base Advisory Committee. Under this plan, which was supported by the groups involved, the CCIS provides the following services:

1. Serves as official representative to the ICPSR (Inter-University Consortium for Political and Social Research) and the ROPER Public Opinion Research Center.

2. Processes all requests for data.
3. Handles the ordering of all data files.
4. Maintains tape security.
5. Publishes lists and information concerning all data holdings.
6. Prepares annual reports to the Library and the Data Base Advisory Committee.
7. Provides consultation services to users who require specialized assistance or who encounter processing or programming problems.
8. Conducts education courses, workshops and seminars to inform people of the availability of data and to teach researchers and educators how to access the files and analyze the data.

The Director of CCIS established the Data Base Advisory Committee that includes representatives of the University Library, user departments, and Princeton University.[1] This committee determines allocation of available resources to the Departments, decides who shall represent Rutgers at ICPSR conferences, and other similar activities.

The centralizing of data archiving is a continuing process and has fostered close cooperation between the CCIS, various departments, the Library, and other institutions.[2]

[1] Princeton and Rutgers have a joint Census Data Project.
[2] For further information see References [20] and [22].

Student Access to Computing Facilities

Several elements determine the "accessibility" of computing facilities to students. These elements include computers and related hardware devices; terminals and their locations; policies regarding uses and users; mechanisms for acquiring account numbers; software; data bases; documentation; support services such as consulting and education; and performance characteristics of the computer systems such as reliability and batch turnaround time.

COMPUTERS

Students at Rutgers use computing facilities provided by the New Jersey Educational Computer Network (NJECN), by the Center for Computer and Information Services (CCIS), and by individual academic departments.

Computer resources available through NJECN include an IBM 370/158 and an IBM 370/168. The 158, operating under MVS, is used to access APL, ATS (Administrative Terminal System), Coursewriter (instructional programming system), six fast-batch compilers and to run administrative jobs. The 168, operating under OS/MVT-HASP, performs batch processing, and operates the timesharing system CALL/OS.

CCIS maintains a DEC KL-20 computer, which is reserved for advanced timesharing research projects; a Hewlett-Packard Access System which serves the specialized needs of timesharing users at the Graduate School of Business Administration, located in Newark; a Hewlett-Packard 3000 which provides support to the Camden College of Arts and Sciences; and a PDP 11-60 at the Engineering School, Busch Campus. A list of computers maintained by the CCIS, the Library and Physical Plant is shown in Figure 2. Academic departments also maintain computers primarily for research with limited instructional use. A list of these is shown as Figure 3.

COMPUTER SYSTEMS INVENTORY
(Rutgers University)
SECTION 1: SERVICE DEPARTMENTS

Service	Computer Equipment	Acquisition Year	Campus
1. CCIS	Hewlett/Packard 2000 Access	1974	Newark
"	IBM 2922	1973	Newark
"	Data 100	1977	Newark
"	Hewlett/Packard 3000-1	1976	Camden
"	DEC PDP 81	1977	Camden
"	DEC PDP 11/60	1978	Busch
"	DEC KL 20	1978	Busch
"	Data 100	1973	Cook
"	Data 100	1977	College Avenue
"	Data 100	1973	Livingston
2. Library	IBM 360/20	1976	College Avenue
3. Physical Plant	Data General NOVA 1200	1975	Busch

Figure 2. **Service Departments' Computers**

COMPUTER SYSTEMS INVENTORY

SECTION 2: ACADEMIC DEPARTMENTS

Department	Computer Equipment	Acquisition Year	Campus
1. Agricultural Eng.	EAI Analog TR 20	1968	Cook
"	COMP DYNA Analog GP-6	1971	Cook
2. Biochemistry and Microbiology	Computer Automation (32K)	1977	Cook
3. Ceramics Engr.	Data General NOVA	(On Loan)	Busch
4. Chemical and Aerospace Engr.	DEC PDP 8E	1973	Busch
5. Chemical Engr.	EAI Analog TR 48	1967	Busch
6. Chemistry – NB	DEC PDP 11/20	1972	Busch
7. Chemistry – Nwk	Data General NOVA 1200	1974	Newark
8. Computer Science	DEC PDP 11/60	1977	Busch
9. Electrical Engr.	DEC PDP 11/03	1977	Busch
"	DEC PDP 11/10	1974	Busch
"	DEC PDP 8I	1968	Busch
"	DEC PDP 5	1964	Busch
"	EAI Analog 580	1968	Busch
"	EAI Analog TR 10	1962	Busch
10. Institute of Animal Behavior	DEC PDP 12	1972	Newark
11. Mechanical, Ind. and Aerospace Engr.	EAI Analog TR 20	1965	Busch
"	EAI Analog TR 20 (1120-X,Y)	1967	Busch
12. Mechanics and Material Science	DEC PDP 11/34	1977	Busch
13. Packaging Science and Engr.	DEC PDP 8I	NA	Busch
"	Honeywell DDP 116	NA	Busch
14. Pharmacy	Wang 16K	1976	Busch
15. Psychology	DEC PDP 8E	1970	Busch
"	DEC PDP 8L	1970	Busch
"	DEC PDP 8L	1969	Busch
"	Data General NOVA 2/10	1974	Busch
"	DEC PDP 11/40	1972	Busch
"	DEC PDP 8L	1970	Busch
16. Physics	DEC PDP 11/45	1975	
"	DEC PDP 9	1968	
"	DEC PDP 10 (utilizing parts of PDP 6 and PDP 8E)	1971 (1965,1964)	Busch
"	DEC PDP 8E-AA	1971	Busch
"	Xerox SIGMA 2	1967	Busch
"	Xerox SIGMA 910	1967	Busch
"	DEC PDP 11/55	1976	Busch
"	Tracor TN 11	1975	Busch
17. Physiology	Picker DAC 512	1970	Busch
18. Waksman Institute of Microbiology	Data General NOVA 1220	1973	Busch

Figure 3. **Academic Departments' Computers**

REMOTE SITES

There are seven remote sites available for computer users. "Remote site" is a location, geographically distant from the main computer, where users can enter batch jobs into the system. These sites each contain a small scale computer with a card reader for sending the jobs to the central computer, and a line printer for producing output, keypunch machines, and low speed terminals for accessing timesharing systems (see terminals below). Floppy disk entry stations are available at the Hill Center.

Newark has two computers used to send jobs to NJECN. They also have an HP-2000 Access computer which is used as a timesharing computer for the Graduate School of Business Administration.

Camden has an HP-3000 computer, used for remote and local batch processing, as well as local timesharing. Their remote batch is processed by the NJECN computers.

New Brunswick has several Data 100 machines to send remote batch jobs to NJECN. These Remotes are located on the College Avenue, Busch, Cook, and Livingston campuses. The Hill Center, on Busch campus, is the main location for computing at New Brunswick.

TERMINALS

In addition to the remote sites for batch jobs, both local and remote timesharing systems may be accessed from more than 175 public terminals placed throughout the University. A list of terminals by location is shown in Figure 4.

GRAPHICS

Computer graphics is a growing field at Rutgers, as at most universities. Equipment includes Tektronix interactive graphic display terminals, Tektronix 4051 stand-alone desk top computers, Tektronix 4662 Interactive Digital Plotter, Graf/Pen Sonic Digitizer, and the Calcomp 936 Drum Plotter.

(47) Hill Center, Busch Campus

8 Teleray
3 Decwriter w/APL
3 Decwriter
8 Datel
10 LSI
3 Tektronix
4 Diablo
2 Hazeltine
2 IBM 3767
3 Data Media
1 Teletype

(11) Tillett Hall, Livingston Campus

2 Decwriter
2 Diablo
5 Teleray w/APL
2 Teletype

(36) Newark

1 Datel
1 Tektronix
1 LSI
1 Teleray
2 Diablo
2 Plato
10 Teletype
17 Decwriters
1 IBM 2741

(19) Graduate School of Library and Information Sciences, College Avenue Campus

4 Teleray
5 Decwriter
3 LSI
3 Teletype
3 Datel
1 Diablo

(5) Engineering Building, Busch Campus

1 Diablo
1 Teleray
1 Tektronix
1 Decwriter
1 Datel

(8) Loree Annex, Cook Campus

2 Teleray
2 Decwriter
1 LSI
1 Datel
1 Diablo
1 Data Media

(20) Camden

6 Teleray
3 Teletype
1 LSI
1 Hazeltine
2 Datel
1 Tektronix
6 Decwriter

Figure 4. **List of Terminals by Location** (Continued)

Figure 4 (Cont.)

(21) Miscellaneous Locations (New Brunswick)

1 Data Media - Douglas Language Lab.
1 IBM 2741 - Kilmer Library
1 LSI - Kilmer Library
1 Datel - Graduate School of Psychology
1 Datel - College of Pharmacy
1 Teleray - Department of Political Science
1 Datel - Livingston College Psychology
2 Datel - Chemistry Department
1 Teleray - Chemistry Department
1 LSI - Douglas Library
1 Datel - Department of Alcohol Studies
1 Teleray - Department of Alcohol Studies
1 Teleray - Library of Science and Medicine
1 Teletype - Graduate School of Education
1 Datel - Institute of Microbiology
1 Decwriter - Department of Environmental Science
1 Datel - University College
1 IBM 2741 - School of Education
1 LSI - Bureau of Economic Research
1 Teletype - Department of Sociology

List of Terminals by Location

OPTICAL SCAN

A Mark-Sense reader (OpScan-17) is used for grading tests and for transferring data to punched cards. The cards are then used as input to statistical packages for analysis of test results. Use of optical scan equipment has shown a significant increase in terms of number of departments and types of applications over the past years.

MICROCOMPUTERS

The New Brunswick CCIS staff attended an intensive course on the design and structure of microcomputers. Five Intel microcomputer trainers were built by the staff, programmed, and then connected to various kinds of peripheral devices. A Cromenco Z-80 was purchased featuring 56K bytes of user memory, a dual floppy disk drive, a dynamic debugging package, an Assembler, a FORTRAN compiler, and a BASIC interpreter.

The Camden CCIS staff started a microprocessor lab with the purchase of two Motorola 6800 processors which were built by the staff. The Motorola cross-assembler and emulator programs were converted by the CCIS staff to operate on the Hewlett-Packard machine to assist students in writing and debugging programs.

ACCOUNTS

All users of the computer must have valid CCIS account numbers. The Departmental Allocation System, an accounting program developed by CCIS, monitors the distribution of computer funds to all academic users for use of the NJECN hardware. To obtain an account number, individuals must receive a computer allocation from their department chairperson. Deans and Department Chairpersons receive computer funds allocations from their provost, which they in turn suballocate to courses, instructors and students. Once a faculty member receives a suballocation, he/she then fills out applications for student course work accounts. CCIS in turn assigns account numbers. A mechanism is set up to request additional funds to be added to the accounts if the original allocation is insufficient. A letter of request is sent to the Director of CCIS, who in turn approves the funds and notifies the accounting office.

More than 17,000 instructional accounts were opened by the CCIS during the 1976-77 academic year. During the same year, 3,200 research accounts were registered.

SOFTWARE

The CCIS and NJECN make available to batch users all the most commonly used computer languages such as Assembler, FORTRAN, COBOL, and PL/1, as well as some special purpose ones such as ALGOL W, LISP, and SNOBOL4. For student use, special versions of five of these languages allow quick processing, fast turnaround time, and extra debugging facilities.

Four timesharing systems are available to CCIS users on the IBM computers operated by NJECN:

APL.SV (A Programming Language) is a scientific and mathematical programming system suited for the occasional users as well as the advanced scientific or technical user.

ATS (Administrative Terminal System) is used for typing, editing, laying out of text, and storage of scientific and research documents which can then be printed accurately in varying formats.

CALL/OS allows users to program interactively in the BASIC, FORTRAN, and PL/1 languages. It has an additional enhancement called COBI (CALL/OS Batch Interface) which enables programs entered at the terminal to be processed in batch mode.

COURSEWRITER III is a Computer Assisted Instruction (CAI) system suited to the development and presentation of educational course material.

For each of the timesharing systems, as well as for the batch system, a wide range of package programs are available. These packages are selected and installed or developed by the CCIS staff. CCIS evaluates new software packages of possible interest to the Rutgers academic community, and there are plans to introduce SUPERWYLBUR, CICS, and CMS during 1978-79.

Packages such as BMD (Biomedical Programs), SPSS (Statistical Package for the Social Sciences), SAS (Statistical Analysis System), STATPACK (a CALL/OS interactive statistical package), and PSTAT (Statistical Package developed at Princeton) are used to correlate and

analyze data. Other programs such as CSMP (Continuous Systems Modeling Program), MPS (Mathematical Programming System), SYMAP (Computer Mapping Program), and GPSS (General Purpose Simulation System) are used for specific applications. Users take advantage of available software for numerical analysis, for gaming and simulation, for accessing data files, and for retrieving information from the 1970 Census of Population and Housing.

COMPUTER-ASSISTED INSTRUCTION

Coursewriter III (IBM supported) and A Tutorial System (ATS, developed by Cornell Medical School under APL.SV) are two CAI languages that may be accessed at Rutgers. CAI courses obtained from other universities are available in many subjects on both of these systems.

During 77/78, PLATO, a nationwide interactive computer-assisted instructional system, was made available on a limited basis through the CCIS. Control Data Corporation awarded a software development grant to Rutgers University for PLATO. The grant will fund development of a tutorial in formal logic for use in the undergraduate philosophy program at Livingston College.

SERVICES

CCIS services and support for instructional and research programs include general and specialized consulting; maintenance and installation of software; assisting and training Rutgers faculty, staff and students in the proper use of computing resources; library services; newsletters and technical documents.

The CCIS maintains AID Stations on all main Rutgers campuses. Trained programmers at AID Stations assist users in interpreting error messages, provide guidance in use of software packages, and help solve computer and programming problems.

College Avenue Remote

The AID Stations, located on the Busch, Newark, College Avenue, Cook-Douglass, Camden, and Livingston campuses, answered over 62,100 user questions in 1976-77.

The Hill Center Aid Station provides assistance to about 150 users during an average day, from 9:00 am until 10:00 pm. A cross-section of users and their problems on a typical day might include:

a faculty person using the computer in relation to research who needs assistance in preparing the JCL required to describe the input and output files from disk or tape;

a faculty person preparing an assignment to be given to students who needs verification of content and format of the handout to be distributed;

a research person receiving a data tape from another university, who needs help interpreting tape labels;

a graduate student using the computer to help prepare a thesis who needs help selecting and using a statistical package;

an upper class student who needs help to interpret an error message indicated by the computer in connection with a classroom assignment;

a student taking his/her first computer course, who is completely confused in trying to differentiate among JCL, a programming language, control cards, and data;

a person from the outside community who calls or comes in to ask questions about computers, what courses are available, and where reading material can be found.

Another type of AID station is hardware-oriented. Hardware AID station personnel service equipment malfunctions and help familiarize users with terminal and keypunch equipment.

DATA ARCHIVES

The CCIS maintains political, social, and economic data in machine-readable form for use in research and study by members of the Rutgers community. Data archiving activities for Rutgers University are centralized at the CCIS. A programmer is in charge of ordering all data, keeping track of tape numbers, data set names, file numbers, making backup takes, writing programs to correct tape problems and/or reformat the data when necessary, as well as conducting user consultations and education seminars.

A complete listing of all data holdings cross-referenced by author, subject and title, is contained in the "Rutgers Guide to Machine-Readable Data Files." Copies of the "Guide" are available at the reference desks of all the University libraries, CCIS Newark and Camden, and the CCIS Computer Reference Center at the Hill Center in Piscataway. Before this listing was created, there was no convenient way for researchers to find out what was available.

Another data archives project is the installation and testing of programs and reference files for the purpose of geocoding. Geocoding is the process of attaching the appropriate Census Bureau geographic identification codes to user files containing addresses. The purpose is to compare these data to Census Bureau statistics and demographic studies and to use the computer to create accurate maps on a plotter and/or line printer using various plotting programs.

EDUCATION[1]

The CCIS offers no-fee, non-credit computer courses to Rutgers faculty, staff, undergraduate and graduate students, and external people as classroom space permits. The CCIS also obtains educational films and video tapes each month on computer-related subjects. The films cover a wide range of topics from general introductory through advanced computer concepts.

COMPUTER REFERENCE CENTER

Technical printed material, the user's key source of information on programming and the latest developments in computer science, is available in the CCIS Computer Reference Center. Conveniently located, the Center is open five days a week and some evening hours. All members of the University community are welcome to use this facility for studying, browsing, and/or research.

A full-time librarian supervises all activities including assisting users in finding information, ordering publications, weeding the collection to keep it up to date, selling CCIS Technical Documents and tapes, reviewing the current literature to alert staff members of articles of interest, and cataloging holdings.

The Center contains copies of the CCIS Newsletter, announcements of interest to users, IBM manuals, DecSystem-20 manuals, books, periodicals, documentation of package programs and newsletters from more than 100 other university computing centers.

A section of the Center called the Data Archives Corner houses all of the ICPSR and ROPER code books, Census Bureau documentation, and publications dealing with our data holdings. The material is organized according to subject matter, and code books are coordinated with the machine-readable data files which they describe.

Audiovisual equipment is available for use in the CCIS Education Series, open houses, conferences, and for any faculty member who wishes to borrow it for use in the classroom for teaching computer-related topics.

[1] See Computer Literacy section for more information on the Education Series.

PUBLICATIONS

The annual "CCIS Information Guide," is a quick reference describing hardware configurations, software, services, and telephone numbers to call for specific assistance. Also published once a year is the "CCIS Faculty Letter" which describes the facilities available to faculty.

"The CCIS Newsletter" and "DECPRINT," are published bi-monthly. Both contain updated information pertaining to computer installations (e.g., hardware changes, software changes, scheduling of computer operations, AID Station hours, and announcements), as well as articles of general interest to computer users, book reviews of current computer literature, and computer humor. CCIS Technical Documents which are written by the staff to provide users with specific software technical information are issued as new implementations are made to the computer systems.

STATISTICAL CONSULTING

The CCIS provides statistical consulting services to graduates and undergraduates, the faculty and researchers to explain how to use statistical packages on the system, to suggest relevant computer programs to do statistical analysis, to provide "debugging" help, and to assist in the interpretation of results. During 1976-77 fiscal year, 943 statistical consultations were held.

GRANT-RELATED SERVICES

CCIS provides consulting services to any member of the Rutgers community applying for external support of research and instructional activities. The CCIS recommends that faculty and students have their grant applications reviewed before submitting them in order to determine if the required computer hardware and software are available for their specific applications and to ensure that the appropriate amount of funds has been budgeted.

USAGE TRENDS

During the academic year 1976-77, about 492,000 batch jobs and 85,500 hours of terminal connect time for timesharing were recorded for Rutgers academic use on the NJECN IBM computers.

The reader will recall from the history section of this report that the IBM computers used at Rutgers for academic timesharing and batch processing were transferred to the New Jersey Educational Computer Network in July 1975. Since that time, usage of major resource items on the central computers has declined due to system performance problems (see Figures 5 and 6).

The PDP 10 (replaced in 1978 by a DEC KL-20), logged 26,068 hours of connect time in 1976-77. The Hewlett-Packard computer in the Graduate School of Business Administration was used for over 14,900 connect hours in the same year.

The Camden campus, which uses a Hewlett Packard 3000 for instructional applications including remedial math and CAI, logged over 9,000 terminal "sessions" and 12,539 batch jobs on the HP machines in 1977-78. Number of batch jobs on the IBM machines was reduced by 15% from 1976/77 to 1977/78, and the number of timesharing sessions reduced by 60% in the same year.

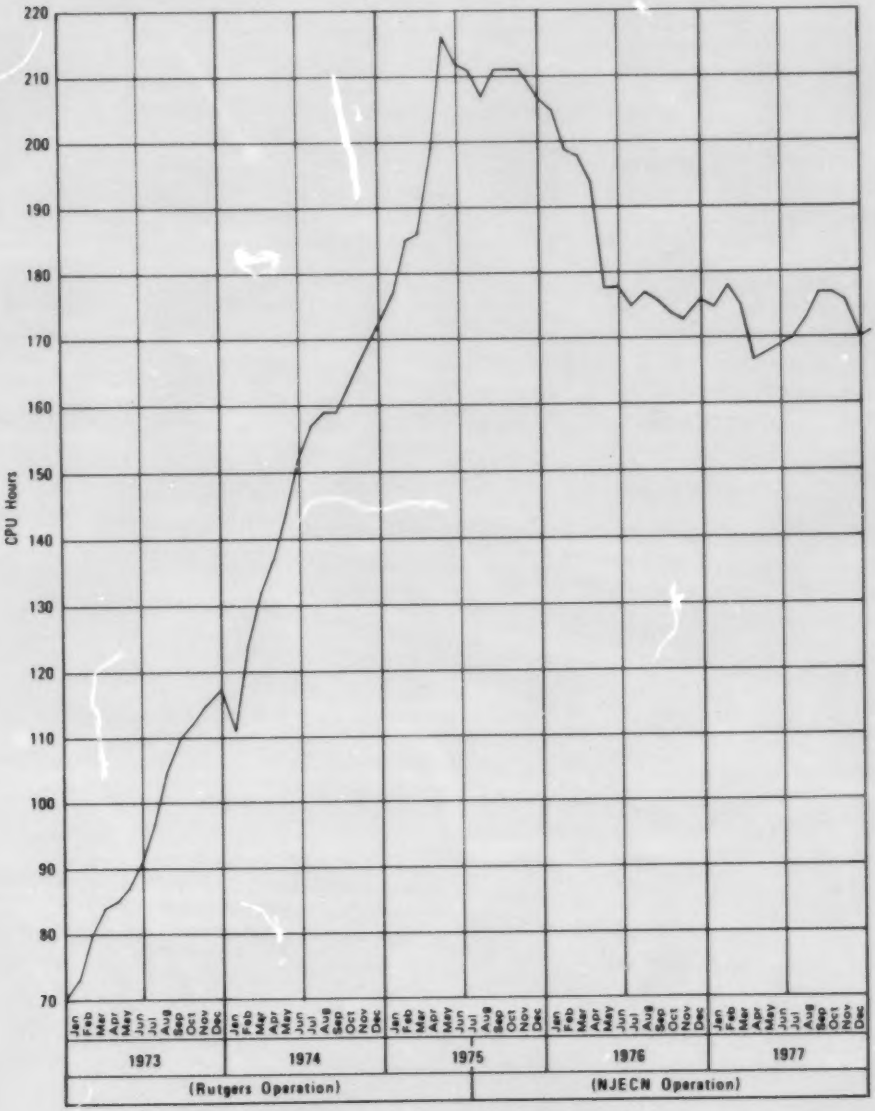

Figure 5. **Total CPU Usage: 12 Term Moving Average (Primary Hardware Only)**

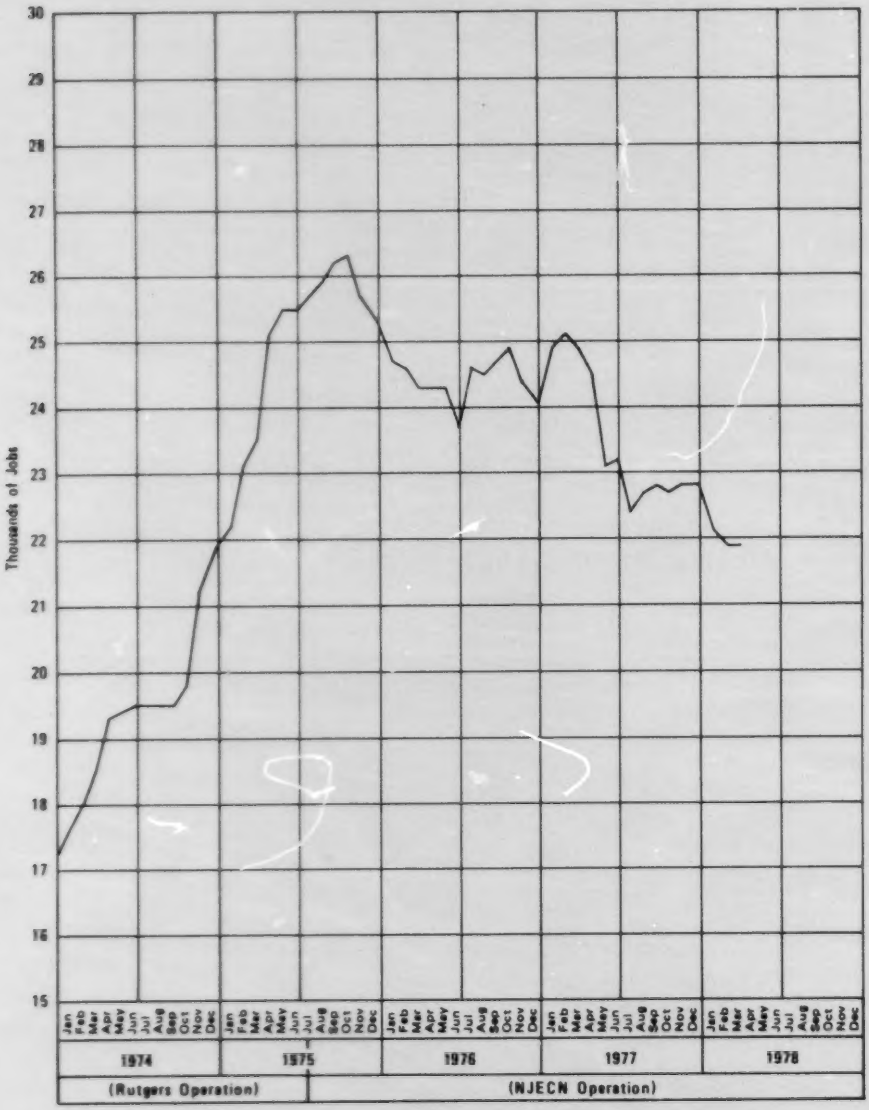

Figure 6. **Non-Fast Batch Jobs: 12 Term Moving Average (Primary Hardware Only)**

Costs and Budgeting

OVERALL COMPUTING EXPENDITURES

The total computer budget for Rutgers University for 1977-78 was $5,871,673 which includes payment of $2,474,900 to the New Jersey Educational Computer Network for services. This includes the three major areas of library, administrative, and academic computing as follows:

Library	$ 438,937
Administrative	$3,012,075
Academic (CCIS)	$2,402,661

These figures do not include costs for computers owned by individual departments.

Computing expenditures for library, administrative and academic computing over the past five years are shown in Figure 7. As indicated in the figure, library expenditures per FTE have increased five-fold over the five years; administrative computing has nearly tripled in cost per FTE; and academic computing has increased only about 10% overall, which represents an actual decrease if inflation is taken into account.

ACADEMIC EXPENDITURES

A breakdown of academic computing expenditures over the past twenty years is shown as Figure 8. Figure 9 relates these same budget figures to hardware installations at Rutgers.

BUDGET PROCESS

The computer budgeting process at Rutgers involves four major components.

1. The State Budgeting Process. Each year Rutgers submits an asking budget to the New Jersey State Legislature. Budget negotiations and compromises take place.

	Library			CCMS Administrative			CCIS Academic			Total Computer Expenditure	FTES[1]	Total Expenditure per FTE
	Expenditure	FTES[1]	Expenditure per FTE	Expenditure	FTES[1]	Expenditure per FTE	Expenditure	FTES[1]	Expenditure per FTE			
72/73 Actual	$ 66,399	30,326	$ 2.19	$ 904,672	30,326	$29.83	$1,707,383	30,326	$56.30	$2,678,454	30,326	$ 33.32
73/74 Actual[2]	73,170	31,739	2.31	1,144,266	31,739	36.05	2,163,855	31,739	68.18	3,381,291	31,739	106.53
74/75 Actual[3]	251,670	35,565	7.08	1,373,984	35,565	38.63	2,140,406	35,565	60.18	3,766,059	35,565	105.89
75/76 Actual[3]	387,977	36,497	10.63	2,312,971	36,497	63.37	2,200,138	36,497	60.28	4,901,086	36,497	134.29
76/77 Budgeted[3]	405,801	38,182	10.63	2,380,121	38,182	62.34	2,342,650	38,182	61.35	5,128,572	38,182	134.32
77/78 Budgeted[3]	438,937	38,259	11.47	3,012,075	38,259	78.73	2,420,661	38,259	63.27	5,871,673	38,259	153.47

[1] Actual FTES for 1972/73-1975-76, budgeted FTES for 1976/77-1977/78.
[2] DHE paid total amount for CAPTAIN and thus is not shown.
[3] Includes NJECN services 1/2 paid by DHE for CAPTAIN not shown.

Figure 7. **Computer Expenditures per FTE for Five Years (1972/73-1975/76 actual and 1976/77-1977/78 budgeted)**

Year	Organization	Approximate Staff Size[1]	Working Budget Breakdown				Working Budget Total
			Personnel[2]	Supplies, Phone, etc.	Rent DP Equipment (344 Account)		
1958-59	Computation Center		$ 15,000	$ 6,200	$ 22,350		$ 43,550
1959-60	"		19,200	5,600	24,050		48,850
1960-61	"		19,150	5,150	25,250		49,550
1961-62	"		25,850	5,650	28,150		59,650
1962-63	"		57,950	11,350	43,300		112,600
1963-64	Center for Information Processing		82,300	15,800	95,000		193,100
1964-65	"		106,600	15,650	173,350		295,600
1965-66	"		120,900	29,950	181,050		331,900
1966-67	Center for Computer and Information Services	15	88,200	32,600	181,050		301,850
1967-68	"		148,600	47,200	331,600		527,400
1968-69	"	27	213,300	48,600	331,600		593,500
1969-70	"	37	347,130	55,570	804,740		1,207,440[3]
1970-71	"		395,000	183,000	865,000		1,443,000[3]
1971-72	"						1,527,018[3]
1972-73	"	44	458,238	328,610	1,070,611	Direct	1,858,459
1973-74	"					Payments to	2,164,744
1974-75	"		760,688	445,884	1,261,848	NJECN	2,468,420
1975-76	"		555,256	165,493	356,375	1,176,604	2,253,728
1976-77	"		636,290	387,550	393,810	1,062,000	2,479,650
1977-78	"	49	677,001	395,575	360,785	987,300	2,420,661

[1] Figures listed represent the approximate number of people employed, not the number of full lines authorized for the center.

[2] Above-the-line salaries plus wages of labor.

[3] Includes funds provided by NSF Facility Grant.

Figure 8. **Academic Computing Working Budget Summary (1958-1978)**

Major Hardware	Year	Working Budget Total	Total University Headcount	Expenditure Per Student
IBM 650	1958-59	$ 43,550	15,308	$ 2.84
IBM 650	1959-60	48,850	16,439	2.97
IBM 650	1960-61	49,550	17,950	2.76
IBM 650	1961-62	59,650	19,890	3.00
IBM 650, 1620	1962-63	112,600	21,610	5.21
IBM 1620, 7040, 1401	1963-64	193,100	23,281	8.29
IBM 1620, 7040, 1401	1964-65	295,600	24,936	11.85
IBM 1620, 7040, 1401	1965-66	331,900	25,554	12.99
IBM 1620, 7040, 1401	1966-67	301,850	26,116	11.56
IBM 7040, 2-1401, 2-1130	1967-68	527,400	27,215	19.38
IBM 7040, 2-1401, 2-1130	1968-69	593,500	28,105	21.12
IBM 360/67, 3-1130	1969-70	1,207,440	31,095	38.83
IBM 360/67 3-1130	1970-71	1,443,000	35,256	40.93
IBM 360/67, 3-1130	1971-72	1,527,018	36,869	41.42
IBM 360/67, 3-1130	1972-73	1,858,459	38,358	48.45
IBM 360/67, 2-1130; DEC PDP 10; HP 2000A	1973-74	2,164,744	40,740	53.14
IBM 370/158, 2-1130; DEC PDP 10; HP 2000A	1974-75	2,468,420	44,469	55.51
IBM 370/158[2], 370/168[2], 2-1130 DEC PDP 10, HP 2000A	1975-76	2,253,728	46,306	48.67
IBM 370/158[2], 370/168[2], 1130; DEC PDP 10; HP 2000A, 3000-1	1976-77	2,479,650	46,491	53.34
IBM 370/158[2], 370/168[2], DEC PDP 10, PDP 8I, PDP 11/60; HP 2000A, HP 3000-1	1977-78	2,420,661	49,045	49.36

[1] Total University Enrollment Information (based on Fall enrollment) was supplied by Rutgers Registrar, (Headcount, not Full-Time Equivalents)

[2] Equipment owned by the New Jersey Educational Computer Network (NJECN)

Figure 9. **Academic Computing Hardware; Cost per Student Summary (1958-1978)**

2. Rutgers Internal Budget. Once the state budget is determined, Rutgers divides its allocated dollars internally among somewhat competing groups. The computing center falls under the General Services part of the budget. In this area, CCIS competes with such departments as the Library, Instructional TV, and Student Services.

3. Internal CCIS Budget. Once the CCIS budget is determined, the Director divides the funds between four cost centers to be maintained. These are as follows:

(1) The IBM Cost Center (New Jersey Educational Computer Network)

(2) The DEC KL-20 Cost Center

(3) The Hewlett-Packard Center in Newark

(4) The Hewlett-Packard Center in Camden

Area managers are held accountable for expenditures. Each year, program objectives are set and the Director adheres to budget expenditures along the lines of these program objectives.

Within the IBM Cost Center, each geographic area (Newark, New Brunswick and Camden) uses the NJECN facilities in addition to their local computers. Therefore, the funds for the IBM Cost Center are allocated to the respective Provosts in the three areas. Then the academic deans, in turn, suballocate funds to the individual departments. The amount and type of computing available to departments is determined by the amount of funds allocated through this departmental allocation system. These funds are used by faculty and students in each department to obtain the computing services they need.

4. NJECN Budget Dollars. The CCIS provides projections of computing resources (CPU time, connect hours, peripheral equipment, etc.) to the NJECN. The NJECN also receives projections from other member institutions. Once this process is completed, a plan for service is developed. Rates are then determined and ECN budget is prepared. If the costs for the projected needs are within the dollars the University had planned to spend, there are no problems. If not, negotiations take place. In the past, for example, the Rutgers academic community had to run 20% of their work load under the discount category so as to keep within the budget. (The discount category does not guarantee turnaround in less than 24 hours.)

Spectrum of Applications

Of the 314 academic departments and subdivisions at Rutgers, 117 use the central computers for instruction. About 350 courses use these computers in an academic semester. Extent of use by the various schools is reflected in Figure 10: Summary of Instructional Computer Accounts 1977-78. These statistics represent over 500 individual course sections and more than 16,000 accounts.

School Name	No. Departments	No. Courses
Livingston College	6	35
Douglass College	9	16
Cook College	11	22
Rutgers College	14	30
College of Engineering	6	26
Graduate School of Education	3	8
The Graduate School	26	99
Graduate School of Library & Information Sciences	1	3
Graduate School of Social Work	2	3
College of Arts & Sciences, Newark	13	26
Graduate School of Business Administration, Newark	2	16
School of Criminal Justice	1	2
College of Pharmacy	1	3
College of Arts & Sciences, Camden	8	18
University College & UED, New Brunswick	7	27
University College & UED, Newark	3	12
University College & UED, Camden	4	6
TOTALS	117	352

Figure 10. **Summary of Instructional Computer Accounts 1977-78**

Students in these courses use the computer facilities in a variety of ways, drawing upon the software and program libraries described in the section, "Student Access to Computing Facilities." The following are examples of courses and applications in selected disciplines.

ART

In 1978, Rutgers established a Computer Art Center at the Mason Gross School of the Creative and Performing Arts.

In the course, "Art and the Machine," undergraduates use a special graphics computer, a Tektronix 4013, and standard computer facilities to apply innovative computer techniques to the world of art. Students work on projects related to their interests. A philosophy student with an informal interest in the guitar composed three part chordal music on the computer. A student with a double major in art and engineering developed cubistic computerized drawings as well as drawings of figures in motion by overlapping an original figure several times to obtain a feeling of movement. An art major developed a computer system for visually representing dance movements; the system provides a method of choreographic notation as well as a means of creating new dance concepts. Another art major switched into computer science after experimenting with the computer to draw trees, distort their size, and shape and experiment with ways to foliate them. An engineering major built designs for suspension bridges and railroad bridges and then rotated the designs, repeating them consecutively until they reached the vanishing point.

In an "Experimental Workshop" in Art offered to Douglass College undergraduates, students use computer facilities to analyze two and three dimensional problems related to painting and sculpture.

BUSINESS

The Graduate School of Business Administration uses its HP 2000 Access timesharing system as well as the central computers for instruction.

Courses using the NJECN central computers include:

Analytical Tools
Analytical Technology
Computer Techniques
Managerial Analyses
Production Management
Financial Accounting
Marketing Management
Economic Analysis
Functions of Management
Economics
Analyses of Business Conditions
Marketing Research
Control Model Management
Industrial Manager Problems
Computer Oriented Accounting

Several departments in the University College offer courses in administration and management that use the central computers:

Administrative Decision Simulation
Marketing Communications
Creative Thinking Management
Marketing
Consumer Behavior
Marketing Research Seminar
Marketing Management
Basic Decisions and Marketing

CHEMISTRY

In General Chemistry and Organic Chemistry courses at the Newark College of Arts and Sciences, students use computer-based tutorials to supplement their regular classroom instruction. The tutorials are a part of the PLATO system library of instructional programs, and are used on PLATO terminals.

More typically, students in chemistry courses use the computers for problem-solving and laboratory data analysis. For example, a student in an independent study project uses curve fitting techniques to store data for temperature dependent ultraviolet absorbance data. Using statistical packages, the data are then analyzed to calculate thermodynamic parameters.

Other chemistry courses using the central computers include:

Rutgers College Chemistry Department
- General Chemistry
- Physical Chemistry
- Research in Chemistry
- Senior Research

Douglass College Chemistry Department
- Physical Instrument Lab
- Organic Analysis

Camden Chemistry Department
- Chemical Principles

Newark Chemistry Department
- Advanced Measurement Lab
- Research in Physical Chemistry

Graduate School Chemistry Department
- Mathematical Methods in Chemistry

COMPUTER SCIENCE

The Computer Science Department is the largest single instructional user of the central computers. Courses are listed in the Computer Science section of this case study.

ECOLOGY

Several departments offer ecology courses in which the computer is used. In "The Computer as an Ecological Tool," entomology students learn computer applications in data manipulation, statistical analysis,

and modeling. In "Quantitative Ecology," Rutgers College zoology graduate students develop experimental ecology models. They then use these models to analyze effects of varying parameters on the stability of the systems. At Cook College, the Entomology and Economic Zoology Department uses the central computers in the course "Animal Ecology" and "Introduction to Ecological Research." The Botany Department at Newark College of Arts and Sciences offers "Field Ecology" in which students use computer-based tools. Graduate students in entomology seminars also use the computer facilities.

INTERDISCIPLINARY

At Livingston College Arts and Sciences Department, a course in "Bibliography and Research Techniques" is taken by students from many disciplines. The students use a series of computer-based tutorials in multiple-choice format. The tutorials draw upon a data base of periodical indexes which the students are learning to search.

ENGLISH

Remedial training is provided for students in Camden who have deficiencies in basic skills. Thirty-two units of basic English, including pronoun antecedents, appositives, punctuation, and basic sentence patterns, are available on interactive terminals. Students use the computer drills to practice basic skills, test themselves on units of work, and receive prescriptions for further study. (See "Student Accomplishments" section).

MATHEMATICS

Students in the remedial math program at Camden College of Arts and Sciences use a Computer-Assisted Math Lab. The Lab provides students with individual diagnoses of weaknesses in basic skills and remedial drills using audio cassettes and slides.

An undergraduate student, doing independent research in the Mathematics Department at Newark College of Arts and Sciences, is studying error propagation and limitations of computer accuracy using such methods as Newton's Method, Simpson's Rule, Trapezoidal Rule, Rhomberg integration, Gaussian Quadrature, and Lagrange polynomials.

Other courses using the central computers include:

Rutgers College Mathematics Department
- Unified Calculus
- Applied Numeric Methods
- Advanced Calculus for Engineers

Douglass College Mathematics Department
- Independent Study

Camden College Mathematics Department
- Finite Math
- Introduction to Mathematical Thought
- Elements of Calculus
- Numerical Methods of Application

Newark College of Arts and Sciences
- Computer Applications
- Math Skills

University College
- Math I
- Discrete Optimization

Graduate School Mathematics Department
- Numerical Analysis
- Mathematical Modeling in the Social Sciences

MECHANICAL, INDUSTRIAL AND AEROSPACE ENGINEERING

MIAE courses in the School of Engineering that use the central computers include:

Industrial Engineering Modeling and Analyses Lab
Quality Control

Operations Research
Seminar
Industrial Engineering Seminar
Mechanical Engineering Communications
Mechanical Control Systems
Machine Control Analysis
Introduction to Aerospace Engineering
Mechanical Design
Computer Methods
Special Topics in Operations Research
Operations Research
Problems in Industrial Engineering
Applications in Fluid Dynamics
Special Projects

Examples of computer use include kinematic analyses and syntheses of a two-gear drive, analysis of balancing of four-bar mechanisms, and minimization of input torque fluctuation.

PHYSICS

Undergraduates at Camden College of Arts and Sciences are introduced to microprocessor technology using four Motorola 6800 processors in the Microprocessor Lab operated jointly by CCIS and the Physics Department. Advanced students use a Motorola 6801 to control laboratory experiments. Software support is supplied by the HP/3000 which has a cross-assembler and an emulator for the Motorola 6800.

Undergraduate Physics students on the Camden Campus also use a group of interactive programs designed to complement specific laboratory experiments. Topics include the ballistic pendulum experiment, simple pendulum experiment, characteristics of a battery experiment, currents in a two loop network experiment, and the prism spectrometer experiment. Additional statistics programs on standard deviation, linear least squares with transformations, and a T-test have been tailor-made for use with the student data obtained in the actual laboratory experiments. The highly specialized Physics programs perform the tedious numeric workup of the lab data, and the programs require that the student answer relevant

technical questions correctly before the results are printed. This group of programs, written in FORTRAN by a Physics instructor at Camden, uses the HP 3000 computer.

A Physics tutorial covering Mechanics, Optics, Wave Theory, Thermodynamics, Electricity and Magnetism, and Modern Physics is also used by Camden Physics students. The tutorials are written in ATS. Students select a topic and are prompted for responses to questions. Students give their responses in sentences using the vocabulary recognized by the tutorial.

Courses using the central computers include:

Camden College of Arts and Sciences
- Elements of Physics
- General Physics
- Elements of Modern Physics
- Electromagnetic Theory
- Advanced Physics Lab

Newark College of Arts and Sciences
- General Physics Lab
- Elements of Physics
- Mechanics

University College
- Physical Analyses
- Physics Instrumentation Lab
- Honors Project

POLITICAL SCIENCE

Political science courses draw upon data archives, statistical analysis packages, and simulation programs. One undergraduate course uses the data bases, "Racial Attitudes in Fifteen American Cities," "Detroit Longitudinal Study," "Negro Political Attitudes," and "Political Participation in America."

A laboratory in political science uses the METRO-APEX simulation discussed in the Student Accomplishments section.

Courses using the central computers include:

Livingston College
- Public Opinion
- Internship in Political Science

Douglass College
- Survey Research

Cook College
- Political Science Lab

Camden College of Arts and Sciences
- Urban Political Systems
- Quantitative Methods

Newark College of Arts and Sciences
- Independent Study

Graduate School
- Constitutional Issues
- Political Socialization
- Voting and Public Opinion
- Advanced Study in Political Science
- Research in American Politics
- Quantitative Methods
- Quantitative Approaches in Political Science

PORTUGUESE

Computer tutorials and drills are used by beginning students to help them learn Portuguese vacubulary. Students who are having difficulty in the course are required to use the computer aids as a supplement to regular classroom instruction.

SOCIOLOGY

Sociology courses draw upon the data archives and data analysis packages. In "Introduction to Social Research," students learn how to

use SPSS programs to analyze social survey data. In another undergraduate course, students are studying "Fear of Crime," data collected by the Census Bureau for the Law Enforcement Assistance Administration (LEAA) covering 26 cities in the United States. Another class is analyzing "The National Longitudinal Surveys" to examine the labor market behavior and experiences of four age-sex subsets of the United States population.

In "Topical Issues in Sociology," an undergraduate course offered by University College, students use census data and ICPSR data to investigate differentials in income in the United States labor force.

Undergraduates taking "Energy in World Perspective" at Cook College use the COALZ energy simulation program to discover the impact of policy changes on the entire world.

Courses using the central computers include:

Rutgers College Sociology Department
- Introduction Sociology Research
- Topics Sociology Analysis

Douglass College Sociology Department
- Independent Research
- Study in Sociology

Cook College Human Ecology Department
- Energy in World Perspective
- Research Methods

Newark College Arts and Sciences Sociology Department
- Methods and Techniques
- Criminology

Camden College Arts and Sciences Sociology
- Population Problems

University College Sociology Department
- Sex Roles and Family
- Issues in Sociology

Graduate School Sociology Department
- Sociology Research Methods
- Sociological Data

Student Accomplishments

What do students accomplish or achieve as a consequence of using computers in their studies? The following summarizes evaluative information regarding three applications. These include a remedial English program, a student grading technique, and a political science laboratory.

CAMDEN REMEDIAL ENGLISH PROGRAM

One hundred and thirty students participated in the Camden remedial English program during 1977-78. The program uses the Basic Skills Laboratory, with several DECwriter hard copy terminals and audio visual stations. The grammar tutorials were developed locally under a grant from the Rutgers Council on Instructional Development. Skills covered include such topics as basic sentence patterns and coordination; adverb and adjective clauses; participial and past participial phrases; subject/verb agreement; pronouns; punctuation; and irregular verbs. lar verbs.

Each student is scheduled for a required one-hour time slot each week. A summary of student usage statistics is sent weekly to the instructors. Students who score below 70% on the weekly computer test are instructed by the tutorial to call up the review unit for further exercises. The hard copy printouts from tutorial sessions make up the grammar text for the students.

The results of the use of CAI were evaluated by comparing pre- and post-tests of these students with two sections as control groups that did not use the tutorials. There seemed to be no appreciable differences between the two groups. A more systematic evaluation of CAI use is being conducted.

Questionnaires filled out by instructors, and interviews with students, indicate that use of CAI improved the quality of instruction in two ways. By mechanizing grammar drill, instructors found they had more class time to devote to specific problems in writing that remedial students face. Instructors used the additional time for analysis of student writing, for longer reading assignments and classroom discussion, and for more work on sentence structure and paragraph development. Second, student enthusiasm for CAI was considerable. The tentative conclusion is that although the use of CAI may not initially improve performance, it may help to improve teacher-student relations and thus establish the basis for greater studen. improvement in writing over the long term.

PEERRATE – A Student Grading Technique

PEERRATE is a computerized technique that makes it possible for students in large lecture courses to evaluate each other's work in a systematic way. Students evaluate each other's oral reports, written class quizzes, and term papers anonymously. Each student rates and is rated by three or more students. The PEERRATE program accounts for rater bias, obtains the standing of each student relative to other students, calculates consistency of students as raters in comparison to independent faculty ratings of the same work, computes means and standard deviations of ratings, and converts the ratings to grades under the direction of the instructor.

The Psychology Department at the Newark College of Arts and Sciences has been a major user of PEERRATE and has perfected usage of the program for grading term papers in large classes.

Approximately 300 graduate and 300 undergraduate students per year are involved in this project. The program has been in operation for three years, following a two-year development period. Two undergraduate courses are using this computerized procedure—Child Development and Introductory Psychology.

Course evaluations are conducted among students regularly. Seventy-five percent of the students recommend continuing this program. The students indicate that the course is more interesting and they learn more. About 25% feel there is no change in learning as a result of the peer rating system.

The cost to calculate grades for one course of 50 students is estimated at $25 currently. This figure includes only hardware and software costs.

PEERRATE has been used extensively in the Graduate School of Business Administration in courses such as Computerized Accounting. The Rutgers Graduate School of Business Administration has used PEERRATE to evaluate the performance of student teams on field work and assignments for corporate and public employees and to evaluate the performance of marketing personnel.

PEERRATE is seen as a potentially useful tool for work evaluation in industry and government, as well as in the classroom. PEERRATE is well suited to improving the quality of ratings. There are three possibilities: members of a work group may rate each other; members of a work group may rate the supervisor; the supervisor may rate the members of the work group.

Note: The listing of source statements on cards or tape is available at cost of materials and processing upon application to Rutgers.

POLITICAL SCIENCE LABORATORY

In a political science laboratory, students are able to test theories and develop interpersonal skills involved in complex political interactions. The laboratory consists of a one-credit course using a computer simulation called METRO-APEX. According to the professor, the simulation "provides students with insight into the complex operations of a system and allows them to test and develop some of the interpersonal skills which real world success requires." Each semester about 35 students take this course, which has been offered since 1975.

METRO-APEX is a computer-based gaming simulation designed to provide a laboratory urban community in which air pollution management trainees apply and test the knowledge and skills gained through conventional educational methods. Students play the roles of city and county politicians, industrialists, environmental control officials, planners, land developers and labor groups. Each playing cycle represents one year in the city.

The computer programs predict the changes that occur in several sectors of the urban system in response to decisions made by student participants, as well as decisions made by simulated persons and external pressures. The computer analyzes decisions made by the players, calculates the changes in the status of the community, and generates output. Output includes tables, maps, summary reports, financial statements, and

a newspaper. This output is provided to players who use the information as the basis for the next cycle.[1]

Student evaluations of the laboratory have been highly positive, citing a wide variety of skills, knowledge and attitude changes as a consequence of the experience. Some students indicated the simulation would be more valuable if it were integrated with lectures, more theory and readings, and made a full three-credit course.

[1] For more information see reference [21].

Computer Literacy

There are three main ways in which students, faculty and staff are encouraged and supported in acquiring computer-related skills.

1. The CCIS provides an education series and special workshops for all members of the University community.
2. Individual schools and departments encourage or require students to acquire computer skills related to their major course of study.
3. Computer Science Department courses serve not only computer science majors but also students from other disciplines who need computer-related skills.

CCIS EDUCATION SERIES

The CCIS Education Series has been in existence since 1971. Similar non-credit training programs have been provided since 1963.

The Education Series is open to all members of the university community including faculty, staff, undergraduate and graduate students, and external people as classroom space permits. Those who attend come from almost every department in the university.

An analysis of registrants by category is as follows:

Faculty	18%
University Staff	18%
Graduate Students	31%
Undergraduate Students	21%
Other (Outside Rutgers)	12%
	100%

The CCIS education program is offered three times a year. Courses are offered in New Brunswick, Newark, and Camden. Some of the courses have only one ninety-minute session, while others meet up to four times for a total of six class-hours.

Each of three education programs contains groups of seminars on basic, introductory computer concepts such as "Everything You Always Wanted to Know About Computers But Didn't Know Enough to Ask" (this course covers the impact of computers in society, namely privacy,

security and computer crimes); "Introduction to Statistics;" and "Introduction to Programming." Some programming languages (PL/1, COBOL, SNOBOL, Assembler Language) are taught on a rotating basis, while FORTRAN and APL are included in every education series.

The use of various systems is taught, including CALL/OS, ATS (Administrative Terminal System), COBI (CALL/OS Batch Interface), and CALLUTIL. A course is given on terminals and another seminar teaches students how to use a stand-alone, desktop, interactive computer, the Tektronix 4051.

For the more knowledgeable students, advanced FORTRAN, Graphics, Data Base Management Systems, Utilities and Data Archieves are taught. Essential to all IBM users is Job Control Language (JCL) so the CCIS provides four 2-hour seminars on this topic during each Education Series. A large portion of every education program is also devoted to statistics and statistical packages (SPSS, SAS, BMD, PSTAT) since many different departments use these programs for analyzing data. The summer mini-series is always devoted to one of these statistical packages. A listing of courses offered during 1977-78 is provided in the table on the following page.

The program is funded by the CCIS; the staff teaches the courses and prepares the handouts given to the students. No academic credit is given for the CCIS Education Series which is offered as a public service and is completely voluntary. The single largest cost of the program is the staff time required for course design and preparation, and for actual teaching. This amounts to approximately $10 per attendee.

The following statistics indicate continuing growth in the demand for this program.

Academic Year	Total Registration
1963/64	300
1968/69	201
1972/73	600
1973/74	3,487
1974/75	3,672
1975/76	5,087
1976/77	6,314
1977/78	6,664

Summary of CCIS Education Series
1977-78

(NB, NWK, and CMD)

Seminar Name	Number of Seminars	Total Registration
Tour	24	503
Intro. to Computers	7	190
Intro. to Programming	3	141
Everything About Computers	6	420
Programming and Debugging Tech.	3	150
Keypunch	1	22
Terminals	5	180
JCL	25	1179
FORTRAN (Elem. & Intermediate)	26	174
COBOL	12	124
PL/1	7	208
BASIC	8	31
WATFIV	1	25
APL	14	432
ATS	2	58
CALL/OS	10	442
CALLUTIL & COBI	6	180
CALLUTIL	2	60
Intro. to Statistics	2	76
BMDP	2	52
SPSS	9	253
SAS	9	516
GLM (SAS)	3	96
STATPKG Overview	1	2
SPSS/COBI	4	188
Data Archives	3	53
Data Base Mgt. Systems	1	31
Utilities	3	104
Graphics	3	102
Tektronix	3	100
TOTAL	205	6,664

Since many people register for more than one of the courses, it is difficult to determine the amount of time that the average person participates. As a rough estimate, each participant in the CCIS Education Series spends 24 hours per year attending seminars.

CCIS PRESENTATIONS

The CCIS staff has been conducting special seminars for groups of users since 1973. This service is available to undergraduate classes, graduate students, faculty and staff. The subject matter and content are tailored to particular interests and needs of the group. These presentations may, for example, deal with the use of one of the timesharing systems or one of the statistical packages, focus on data archives, microprocessors or a programming language or provide a general introduction to computers and to the facilities and services provided by the CCIS.

A one-day campus-wide special conference or open house is also held each year with each year's conference having a different theme, such as "Computers in Art," or "Creative Classroom Computing."

The program is supported by the CCIS, and no academic credit is given for the workshops and special conferences unless a faculty member requests them as part of a regularly scheduled course.

The number of participants in special presentations varies widely from year to year. In 1976-77, for example, there were five individual workshops each lasting about 3 hours, with an average of 10 persons per workshop, while in 1977-78 more than 100 people attended special seminars. Each year about 150-200 persons come to the one-day special presentation or open house.

SCHOOL AND DEPARTMENT LITERACY REQUIREMENTS

In 1964, the College of Engineering faculty voted to require all freshmen to take a one-credit course in Basic Computer Programming. Since that time, many of the university's colleges and academic departments have instituted computer literacy requirements for their students.

According to a survey made in May 1978, computer literacy is a requirement for students within the following schools and departments:

Newark Campus
- Economics Department
- Graduate School of Business Administration
- Institute of Animal Behavior
- Rutgers College of Nursing
- Sociology Department

Camden Campus
- Business and Economics Department
- Physics Department

New Brunswick Campus

College of Engineering
- Ceramic Science and Engineering Department
- Chemical and Biochemical Engineering Department
- Civil and Environmental Engineering Department
- Electrical Engineering Department
- Mechanical and Aerospace Engineering Department
- Packaging Science and Engineering Department

Douglas College
- Home Economics Department
- Mathematics Department

Livingston College
- Computer Science Department
- Nursing Department
- Political Science Department

Rutgers College
- Geosciences Department
- Health and Physical Education Department

Cook College
- Agricultural Economics and Marketing Department

Biology and Agricultural Engineering Department
Environmental Studies Department
Meteorology Department

College of Pharmacy
Bureau of Economic Research
Psychology Department

Departments such as the following require programming proficiency for majors:

Newark Campus
Economics Department
Graduate School of Business Administration
Institute of Animal Behavior

Camden Campus
Business and Economics Department
Physics Department

New Brunswick Campus

College of Engineering
Chemical and Biochemical Engineering Department
Electrical Engineering Department
Mechanical and Aerospace Engineering Department
Packaging Science and Engineering Department

Livingston College
Computer Science Department

Cook College
Agricultural Economics and Marketing Department
Biology and Agricultural Engineering Department
Meteorology Department

Other departments encourage, but do not require, computer literacy:

Camden Campus
- Chemistry Department
- Psychology Department
- Sociology Department

New Brunswick Campus

Douglass College
- Economics Department
- Education Department

Livingston College
- Anthropology Department
- Urban Studies Department

Rutgers College
- Physics Department

COMPUTER SCIENCE COURSES

In addition to providing programs of study for graduate and undergraduate majors in computer science, the Department of Computer Science has the goal of satisfying the computer literacy needs of students majoring in other fields. "Our goal is to reach a point early in the coming decade where the equivalent of half the freshman class of all the colleges in New Brunswick will be exposed each year to our introductory course in computing."[1]

The computer science curriculum does not include special service courses for non majors. Both CS majors and students from other disciplines take the Introductory Computer Science course, followed by other courses as appropriate. For students majoring in scientific, mathematical and engineering fields, a course sequence in numerical methods and computer problem-solving is recommended. For students in the social and behavioral sciences and humanities, the courses in non-numerical problems

[1] Amarel (1978).

and programming, and computer methods in statistics, are recommended. Courses in data processing, information processing methods, data base management and management information systems are available for students in management, business, urban administration and accounting.

Total undergraduate course enrollment in AY 1977-78 was 3,725, a 23% growth relative to the previous year when enrollment was 3,040. Enrollment in the Introductory course grew from 1,350 in AY 1976-77 to 1,652 in AY 1977-78. Approximately 383 of the undergraduates are computer science majors. According to the Department's Annual Report for Academic Year 1977-78,[1] the growth rate in the Introductory course will be kept to less than 20% per year.

[1] Amarel (1978).

Computer Science Programs

The Computer Science Department was established at Rutgers in 1966. In 1970 the undergraduate program was extended, and in 1974 was restructured. In 1970 the graduate program was also extended and restructured; a Ph.D. program was introduced and the Masters program was modified to integrate well with the doctoral program.

The department offers programs leading to the Bachelor's, Master's, and Ph.D. degrees in Computer Science; the Masters of Philosophy is also available.

The programs are administered by the New Brunswick Computer Science Department. The Chairman of the New Brunswick Department and Director of graduate programs is Dr. Saul Amarel. Computer Science faculty are mainly affiliated with Livingston College, but also with Cook College, University College, and the Graduate School.

Programs are open to students in the Livingston, Cook, Douglass, Rutgers and University Colleges of Rutgers University in New Brunswick. There are about 400 undergraduate majors and about 270 graduate students of which 25% are full-time.

The total undergraduate student enrollment in computer science courses in AY 1977-78 was 3,725, a 23% growth in undergraduate enrollment relative to the previous year.

There are 26 full-time faculty members in the New Brunswick Department of Computer Science, and 8 part-time and visiting faculty.

UNDERGRADUATE CURRICULUM

The undergraduate curriculum is designed to prepare students for either graduate studies or employment. A major in computer science must take a minimum of 11 courses in the department, of which 7 are required and 4 are elective. A list of undergraduate course titles is shown in Figure 11.

GRADUATE CURRICULUM

The emphasis of the program is on the relationship and mutual impact of computers and applications areas, and on problems of system design. Research is encouraged in the context of applications of artificial intelligence in biomedicine, psychology, law and education. Research is also encouraged in operating systems, data bases, automatic programming, computer networking, and numerical computing and programming theory.

	Required Courses for Majors in Computer Science	Enrollment Fall 1977	Enrollment Spring 1978
111	Introduction to Computing	983	669
205	Introduction to Discrete Structures	238	
215-216	Computers and Programming	304	332
306	Discrete Probability Theory and Combinatorial Analysis		123
323	Numerical Problems and Computer Programming	78	
344	Non-Numerical Problems and Computer Programming		122
	Elective Courses and Areas of Concentration		
	General		
101	Elementary Problem Solving Using Computers		
201-202	Independent Study A	17	4
403-404	Independent Study B	2	7
405	Computers and Society		
	Computer Systems and Programming		
114	Introduction to Programming Languages		295
315	Language Software	65	
411-412	Software Laboratory A & B	15	4
416	Operating Systems Design		31
418	Operating Systems Laboratory		26
351-352	Logic Design		
470	Computer Organization		
	Numerical Applications of Computers		
221	Numerical Problems Computer Programming	32	45
324	Numerical Analysis		16
421	Numerical Methods in Ordinary Differential Equations		
424	Modeling and Simulation of Continuous Systems		23
425	Computer Methods in Statistics		17
	Data Processing and Management Applications of Computers		
231	Introduction to Data Processing	143	
332	Information Processing Methods		66
435	Data Base Management	45	
436	Management Information Systems		21
	Non-Numerical Applications		
442	Seminar in Non-Numerical Applications		7
	Theory of Computation		
452	Topics in Computer Theory		5

Figure 11. **Undergraduate Computer Science Course Titles and Enrollment**

Graduate courses offered are listed under the specializations with which they are most closely related, shown as Figure 12.

Thirty credits are required for the Master's degree. An optional arrangement allows for a Master's Thesis for which 6 credits of coursework are received. The Ph.D. program emphasizes research, project work, active participation in seminars and colloquia, interdisciplinary involvement in computer applications, and a flexible program of course work. Required total credits for course work is 48.

GRADUATE PLACEMENT

There is no comprehensive follow-up on employment of computer science graduates; however employment offers are reported on a voluntary basis to the Career Development and Placement Services. In 1978, BS graduates reported employment in programming, systems design, and computer engineering, at starting salaries ranging from $9500 to $16,900. Job placement for graduates from Computer Science is about 100%.

Students obtain part-time work through the CCIS, which employs about 70 students per year for the AID stations, and through the Department of Computer Science, which supports about 60 graduate students with fellowships, teaching assistantships, and research assistantships.

RESEARCH

Research by the faculty is in areas of artificial intelligence, computer applications in medicine, psychology and law, knowledge-based systems, language processing, computer modeling, automatic programming, data base design programming theory, numerical computing and instructional systems.

A major part of faculty research is supported by an NIH grant for a Special Research Resource on Computers in Biomedicine. The emphasis of this research is on diagnostic problem solving and on problems of representation and modeling that appear in biomedical inquiry. Related to this research is the department's participation in the national Artificial Intelligence in Medicine program. The department has access to the SUMEX-AIM computer at Stanford through TYMNET and the ARPANET. Many of the

Artificial Intelligence and its Applications

- Non-Numerical Algorithms
- Introduction to Artificial Intelligence
- Advanced Non-Numeric Algorithms and Heuristics
- Natural Language Processing and Question Answering by Computer
- Pattern Recognition: Theory and Application
- Pattern Recognition II
- Topics in Computers in Education
- Topics in Computers in Biomedicine
- Topics in Artificial Intelligence

Foundations of Computer Science

- Computer Structures
- Introduction to Sequential Machines
- Theory of Formal Languages
- Formal List Processing
- Theory of Computation
- Topics in the Foundations of Computer Science

Computer Systems

- Computer Structures
- Introduction to Sequential Machines
- Machine Organization
- Topics in Computer System Organization

Operating Systems

- Introduction to System Programming
- Operating Systems
- Data Base Systems
- Topics in Operating Systems

Figure 12. **Graduate Course Titles** (p. 1 of 2)

Programming and Languages

- Advanced Programming Techniques
- Introduction to System Programming
- Non-Numerical Algorithms
- Programming Languages and Compilers I and II
- Advanced Non-Numeric Algorithms and Heuristics
- Theory of Formal Languages
- Topics in Design and Implementation of Programming Languages I and II

Information Systems

- Data Base Systems
- Generating Information Systems

Numerical Computing

- Numerical Analysis
- Computational Methods for Optimization Problems
- Network and Discrete Optimization Algorithms
- Advanced Numerical Analysis I and II
- Computer Methods for Partial Differential Equations
- Optimization Theory and Computational Methods
- Problems in Numerical Methods I and II

Modeling, Simulation and Optimization

- Systems Modeling
- Computational Methods for Optimization Problems
- Network and Discrete Optimization Algorithms
- Problems in Simulation

Special Applications

- Computer Graphics
- Natural Language Processing and Question Answering by Computer
- Pattern Recognition, Theory and Applications I and II
- Problems in Computer Graphics
- Topics in Computers in Education
- Topics in Computers in Biomedicine

Other seminars and problems courses provide opportunities for introducing new topics and current research in the field.

Figure 12. Graduate Course Titles (p. 2 of 2)

advanced courses in computer science are related to the faculty research and provide the students with opportunities for developing their own skills and interests.

COSTS

The cost of the computer science programs, including computer costs and salaries, is about $2 million per year.

STUDENT ACCOMPLISHMENTS

References provide examples of student work. The software project ANALYZER is a program used by experimental physicists and operates at the Rutgers Nuclear Physics Laboratory (Ref. 16). This realtime operating system controls nuclear accelerator experiments. Another graduate student conducted an analysis of data network requirements for the New York City Region through 1980, conducted in conjunction with the Bell System. "First Discovery of America" (Ref. 15), is a computer model which examines dynamic interactions of human and animal populations in a given geographical area. Other doctoral research has resulted in model-based expert systems for diagnosis and treatment of glaucoma.

Outreach

Academic computing at Rutgers reaches out to other institutions through the sharing of computer software, expertise, and courses.

SOFTWARE SHARING

The computer hardware facilities of the New Jersey Educational Computer Network (NJECN) are shared by Rutgers University, New Jersey Institute of Technology, New Jersey College of Medicine and Dentistry, eight state colleges, nine community colleges, and eleven independent colleges. As the largest member of the network, Rutgers often purchases and leases software packages which are put up on the system and then are accessed by all participating educational institutions. Examples of this sharing of software include International Mathematical and Statistical Libraries (IMSL) and the graphics packages, SYMAP and SYMVU.

Rutgers CCIS also distributes public data files and associated programs to outside institutions. Non-proprietary software available from the United States government and from nonprofit agencies, such as census data and census-related computer programs, are made available to local and state agencies. CCIS provides these more quickly and at a lesser fee than the Census Bureau does, and more customized service is provided. For example, a series of computer programs for use with census data were copied and sent to the Newark Planning Board along with a data tape containing all of the information from the third and fourth count census files for the city. Similar services are provided to a variety of educational, governmental, and commercial organizations around the state.

EXPERTISE

The Rutgers Research Resource on Computers in Biomedicine has been sponsoring an annual workshop on artificial intelligence in medicine. From fifty to 150 persons from universities throughout the country attend these workshops. Included are investigators from the fields of chemistry, psychology, medicine, computer science, and others. The conferences provide discussions, demonstrations, paper presentations and hands-on systems experience in aspects of artificial intelligence in medicine such as medical

modeling and decision making for diagnostic/therapeutic consultation, psychiatric simulation, medical visual information processing, and biomolecular characterization of organic molecules. (Reference A.I.M. proceedings.)

COURSES

CCIS Education Series courses are open to the general public. About fifty such persons a year take advantage of this public service, usually attending introductory courses in computers, programming, and languages.

Plans and Goals

In early 1978, the management and staff of the CCIS closely examined the goals and objectives of the Rutgers University CCIS for the two-year period beginning in Fiscal Year 1978-79. A clear direction emerged for future planning, i.e. - the CCIS should devote its energies to computer resource development and management. The second factor which emerged is that the basic areas of involvement on the part of the CCIS staff are sound, and an expansion of these activities to reflect new developments is what is needed, not the creation of completely new staff functions. With this in mind, the following list of goals intended to act as a decision-making guide in the areas of computer resource allocation and management, was established:

1) Computer Based Education. Faculty and students should have the opportunity to be exposed to the instructional capability of systems such as PLATO, and be able to investigate the academic merits of such systems.

2) Data Archives. The current collection of data files should be expanded so as to provide researchers and instructors with a wide variety of current and historical information. Particular attention should be paid to planning for the acquisition and processing of the 1980 Census data with an eye to possibly becoming the State Data Center for New Jersey.

3) Specialized Laboratory Facilities. Students from a variety of disciplines should be provided the opportunity to have hands-on experience with microprocessors, computer graphics, and other innovations that will be useful to them in their chosen careers. A laboratory facility should be established for this purpose.

4) Telecommunications and Networking. No single university possesses the resources to make all forms of computer service available to its faculty and students. Networking systems, such as EDUNET, should be evaluated to see if their availability would enhance faculty research capability and would provide a broader range of options for students.

5) Institutional Research. Requests for assistance with institutional research projects from offices of Deans and Provosts should be supported by a designated person at the CCIS.

6) Standalone Systems for Rutgers Remotes. Technological developments and reduced costs concerning mini and micro processors make these systems attractive alternatives for a variety of applications. Certain applications could be more appropriately handled by making such systems available to users through the Rutgers remote station network.

7) Expanded Hardware Service and Maintenance. The CCIS supports a hardware maintenance group which services peripheral equipment owned or leased by the CCIS. This has been demonstrated to be more cost-effective than using vendor service contracts. This service should be xpanded to include equipment owned by other departments and projects, including microprocessor equipment.

8) Open Student Accounts. As described in the section on Student Access to Computing Facilities, students presently must receive permission to obtain a user account number through their teachers and departments. Consideration should be given to other systems such as the Dartmouth University strategy of providing open student accounts, in order to expand computer literacy among the undergraduate population. A strategy should be developed to initiate such a program, tied to a formal assessment of its impact.

9) Faculty Liaison. Improved methods of identifying faculty interests and needs should be devised. By formalizing this activity, a more comprehensive view of faculty needs could be developed.

10) Relations With New Jersey Educational Computing Network. In the interests of high quality service to users, the CCIS staff commit themselves to doing everything possible to expand cooperation with the computer network vendor, the NJECN.

11) Enhancement of CCIS Inter-Campus Communication. A strategy will be developed to involve, at a minimum, regular meetings of campus CCIS managers for the purpose of sharing information, problem solving, and needs analysis. Each campus can benefit from exchange of information on hardware and software development and support services.

12) Analysis of Current CCIS Staff Utilization and Future Staff Needs. Each CCIS manager should reassess staff assignments in light of current and future goals, and determine if in fact the most productive use of staff resources is being made.

Lessons Learned

As a State University, Rutgers has faced questions that are common to many institutions of higher education with regard to computing—issues of networking; centralization versus decentralization, and delivery of user services. In reviewing these issues as they have been addressed in New Jersey and by Rutgers, Richard Storer, the Director of CCIS, finds that the important factor lies in the nature of planning and the related decision process.

He has become convinced that the key factor to managing computer growth in a rational manner is overall planning. Within a large university such as Rutgers, it becomes very difficult to coordinate the planning process. The central point of overall planning is the question of who is in control. In order to overcome the control issue, coordinated planning must take place at the following levels:

Local Planning at the Department level;
College Planning at the Dean level;
Unit Planning at the Provost level; and
Overall Planning at the President level.

Once objectives could be determined, computing centers could tailor their programs to these objectives. Managers of computer centers would be accountable and would be measured by their contributions towards meeting these objectives. There would be common goals established throughout the organization. Due to the rapidly changing technology, plans would be constantly reviewed to help assure the objectives of the community are met. In this way it would be possible to address current and future problems in a coordinated or team way.

Many decisions relating to the major issues of educational computing are made due to immediate pressure, without foresight towards the future impact of these decisions. Storer believes that if the planning process were rationally organized at all levels, it would be easier to address these inevitable issues in a way that would be of benefit to users in the long run. Decisions could be made that would minimize risk to the institution.

Contacts

Readers wishing to obtain additional information about academic computing at Rutgers should contact the office of the Director of the Center for Computer and Information Services, Richard Storer. The reader will be directed from this point to the appropriate person who can supply the information.

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